Designation: A 453/A 453M – 94

Standard Specification for Bolting Materials, High-Temperature, 50 to 120 ksi [345 to 827 MPa] Yield Strength, With Expansion Coefficients Comparable to Austenitic Steels[1]

This standard is issued under the fixed designation A 453/A 453M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification[2] covers four grades of bolting materials with nine classes of yield strength ranging from 50 to 120 ksi [345 to 827 MPa] for use in high-temperature service such as fasteners for pressure vessel and valve flanges. The material requires special processing and is not intended for general purpose applications. The term "bolting material," as used in this specification, covers rolled, forged, or hot-extruded bars; bolts, nuts, screws, washers, studs, and stud bolts. Headed bolts and rolled threads may be supplied.

NOTE 1—Other bolting materials are covered by Specification A 193/A 193M and Specification A 437/A 437M.

1.2 Supplementary Requirement S1 of an optional nature is provided. This shall apply only when specified by the purchaser in the order.

1.3 This specification is expressed in both inch-pound units and in SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the material shall be furnished to inch-pound units.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service[3]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[4]

A 437/A 437M Specification for Alloy-Steel Turbine-Type Bolting Material Specially Heat Treated for High-Temperature Service[3]

E 30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron[5]

E 59 Practice for Sampling Steel and Iron for Determination of Chemical Composition[5]

E 139 Practice for Conducting Creep, Creep-Rupture, and Stress-Rupture Tests of Metallic Materials[6]

2.2 *ANSI Standards:*[7]

ANSI B1.1 Unified Screw Threads

ANSI B18.2.1 Square and Hex Bolts and Screws Including Hex Cap Screws and Lag Screws

ANSI B18.2.2 Square and Hex Nuts

ANSI B18.3 Hexagon Socket and Spline Socket Screws

2.3 *AIAG Standard:*

AIAG B-5 02.00 Primary Metals Identification Tag Application Standard[8]

3. Terminology

3.1 *Descriptions of Terms Specific to This Standard:*

3.1.1 *bolting material*—this covers rolled, forged, or hot-extruded bars; bolts, nuts, screws, washers, studs, and stud bolts; and also includes those manufactured by upset heading or roll threading techniques.

3.1.2 *heat-treatment charge*—one heat of material heat treated in one batch. If a continuous operation is used, the weight processed as a heat-treatment charge shall not exceed the weights in Table 1.

3.1.3 *lot*—a lot shall consist of the quantities shown in Table 2.

4. Ordering Information

4.1 The inquiry and order shall indicate the following:

4.1.1 Quantity (weight or number of pieces),

4.1.2 Type of material (bars, bolts, nuts, etc.),

4.1.3 Grade and class,

4.1.4 Method of finishing (see 5.2),

4.1.5 Type of thread desired (see 5.2.2),

4.1.6 Alternative test method option (see 7.2.4.3),

4.1.7 Bolt shape option, if any (see 8.2),

4.1.8 Thread option, if any (see 8.3),

4.1.9 Test method for surface quality, if any (see Section 10),

---

[1] This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel, and Related Alloys and is the direct responsibility of Subcommittee A01.22 on Valves and Fittings.

Current edition approved June 15, 1994. Published August 1994. Originally published as A 453 – 61 T. Last previous edition A 453/A 453M – 93.

[2] For ASME Boiler and Pressure Vessel Code Applications see related Specification SA-453 in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 01.01.

[4] *Annual Book of ASTM Standards*, Vol 01.03.

[5] *Annual Book of ASTM Standards*, Vol 03.05.

[6] *Annual Book of ASTM Standards*, Vol 03.01.

[7] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

[8] Available from Automotive Industry Action Group, 26200 Lahser, Suite 200, Southfield, MI 48034.

TABLE 1 Continuous Heat-Treatment Charge Sizes

Diameter, in. [mm]	Weight, lb [kg]
To 1¾ [44]	3000 [1400]
Over 1¾ [44] to 2½ [63]	6000 [2700]
Over 2½ [63]	12000 [5400]

TABLE 2 Lot Sizes

Diameter, in. [mm]	Maximum Lot Size, lb [kg]
1½ [38] and under	200 [90]
Over 1½ [38] to 1¾ [44], incl	300 [140]
Over 1¾ [44] to 2½ [63], incl	600 [270]
Over 2½ [63]	20 pieces

4.1.10 Test location option, if any (Section 11),
4.1.11 Rejection option, if any (see 12.1), and
4.1.12 If stress-rupture testing is not required (see 7.2.1).

5. Materials and Manufacture

5.1 *Melting Process:*

5.1.1 The material shall be made by one or more of the following processes: electric-furnace, induction furnace, or consumable-electrode practice.

5.1.2 Vacuum, protective atmospheres, or protective slags may be used during melting or pouring of the heat.

5.2 *Finishing Process:*

5.2.1 The product shall be hot finished or cold finished (ground, rough turned or cold drawn) as specified on the purchase order.

5.2.2 Threads may be formed by machining or rolling. For Type 1 bolting, threading shall be performed after precipitation heat treatment. For Type 2 bolting, threading shall be performed after solution treatment but prior to precipitation heat treatment.

5.3 *Heat Treatment*—Each grade and class shall be heat treated as prescribed in Table 3.

6. Chemical Composition

6.1 *Heat Analysis*—An analysis of each heat of steel shall be made by the manufacturer to determine the percentages of the elements specified in Table 4. This analysis shall be made from a test sample taken during the pouring of the heat. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Table 4.

6.1.1 Steels with added lead shall not be used.

6.2 *Product Analysis:*

6.2.1 A product analysis may be made by the purchaser from tension samples representing the bolting material.

6.2.2 Samples for chemical analysis, except for spectrochemical analysis, shall be taken in accordance with Practice E 59. The chemical composition thus determined shall conform to the requirements for product analysis variation as specified in Table 4.

6.2.3 A product analysis shall be made by the manufacturer of bar stock made from vacuum-arc remelted steel.

6.3 *Methods of Analysis*—For referee purposes, Test Methods E 30 shall be used.

7. Mechanical Properties

7.1 *Tension Test:*

7.1.1 *Requirements*—The material shall conform to the room-temperature tensile in each heat-treatment charge (Section 3).

7.1.2 *Number of Specimens:*

7.1.2.1 *Heat-Treated Bars*—When not more than two sizes of bars are heat treated in the same load, one tension test shall be made from each size in each heat of material in the heat-treatment charge (see 3.2). When more than two sizes of bars are treated in the same charge, one tension test shall be made from one bar of each of the two largest diameters from each heat of material in the heat-treating charge.

7.1.2.2 *Finished Parts*—One tension test shall be made if the lot consists of parts of the same nominal diameter. If the lot consists of parts of more than one nominal diameter, one tension test shall be made from each nominal diameter of each heat involved in the lot (Section 3).

7.1.2.3 The diameter range shall be in increments of ½ in. [12.5 mm].

7.1.2.4 Tension tests are not required on finished parts that are fabricated from heat-treated bars furnished in accordance with the requirements of this specification and tested in accordance with 7.1.2.1, provided they are not given a subsequent heat treatment.

7.1.3 *Test Location and Orientation*—Specimens shall be taken in accordance with Test Methods and Definitions

TABLE 3 Heat Treatment Requirements[A]

Grade	Class	Solution Treatment	Hardening Treatment
660	A	1650 ± 25°F [900 ± 14°C], hold 2 h, min, and liquid quench	1325 ± 25°F [720 ± 14°C], hold 16 h, air cool
	B	1800 ± 25°F [980 ± 14°C], hold 1 h, min, and liquid quench	1325 ± 25°F [720 ± 14°C], hold 16 h, air cool
	C	1800 ± 25°F [980 ± 14°C], hold 1 h min, and oil quench	1425 ± 25°F [775 ± 14°C] hold 16 h, air cool 1200 ± 25°F [650 ± 14°C] hold 16 h, air cool
651	A		hot-cold worked at 1200°F [650°C] min with 15 % min reduction in cross-sectional area, stress-relief anneal at 1200°F [650°C] min or 4 h, min
	B		hot-cold worked at 1200°F [650°C] min with 15 % min reduction of cross-sectional area, stress-relief anneal at 1350°F [730°C] min for 4 h, min
662	A	1800 ± 25°F [980 ± 14°C], hold 2 h, liquid quench	1350 to 1400°F [730 to 760°C], hold 20 h, furnace cool to 1200 ± 25°F [650 ± 14°C], hold 20 h, air cool
	B	1950 ± 25°F [1065 ± 14°C], hold 2 h, liquid quench	1350 to 1400°F [730 to 760°C], hold 20 h, furnace cool to 1200 ± 25°F [650 ± 14°C], hold 20 h, air cool
665	A	1800 ± 25°F [980 ± 14°C], hold 3 h, liquid quench	1350 to 1400°F [730 to 760°C], hold 20 h, furnace cool to 1200 ± 25°F [650 ± 14°C], hold 20 h, air cool
	B	2000 ± 25°F [1095 ± 14°C], hold 3 h, liquid quench	1350 to 1400°F [730 to 760°C], hold 20 h, furnace cool to 1200 ± 25°F [650 ± 14°C], hold 20 h, air cool

[A] Times refer to the minimum time material is required to be at temperature.

TABLE 4 Chemical Requirements

	Grade 660		Grade 651	
	Content, %	Product Analysis Variation, Over or Under, %	Content, %	Product Analysis Variation, Over or Under, %
Carbon	0.08 max	0.01 over	0.28–0.35	0.02
Manganese	2.00 max	0.04	0.75–1.50	0.04
Phosphorus	0.040 max	0.005 over	0.040 max	0.005 over
Sulfur	0.030 max	0.005 over	0.030 max	0.005 over
Silicon	1.00 max	0.05	0.30–0.80	0.05
Nickel	24.0–27.0	0.20	8.0–11.0	0.15
Chromium	13.5–16.0	0.20	18.0–21.0	0.25
Molybdenum	1.00–1.50	0.05	1.00–1.75	0.05
Tungsten	...	...	1.00–1.75	0.05
Titanium	1.90–2.35	0.05	0.10–0.35	0.05 over
Columbium[A]	...	...	0.25–0.60	0.05
Aluminum	0.35 max	0.05 over	...	...
Vanadium	0.10–0.50	0.03	...	...
Boron	0.001–0.010	0.0004 under to 0.001 over	...	...
Copper	...	...	0.50 max	0.03 over

	Grade 662		Grade 665	
	Content, %	Product Analysis, Variation Over or Under, %	Content, %	Product Analysis Variation, Over or Under, %
Carbon	0.08 max	0.01 over	0.08 max	0.01 over
Manganese	0.40–1.00	0.03	1.25–2.00	0.04
Phosphorus	0.040 max	0.005 over	0.040 max	0.005 over
Sulfur	0.030 max	0.005 over	0.030 max	0.005 over
Silicon	0.40–1.00	0.05	0.10–0.80	0.05
Nickel	24.0–28.0	0.20	24.0–28.0	0.20
Chromium	12.0–15.0	0.15	12.0–15.0	0.15
Molybdenum	2.0–3.5	0.10	1.25–2.25	0.10
Titanium	1.80–2.10	0.05	2.70–3.3	0.05
Aluminum	0.35 max	0.05 over	0.25 max	0.05 over
Copper	0.50 max	0.03 over	0.25 max	0.03 over
Boron	0.001–0.010	0.0004 under to 0.001 over	0.01–0.07	0.005

[A] Or columbium plus tantalum.

A 370, Annex A1, from the bar stock used to make the product.

7.1.4 *Test Methods:*

7.1.4.1 The tension test specimen shall be machined to the form and dimensions prescribed in the latest issue of Test Methods and Definitions A 370.

7.1.4.2 The yield strength shall be determined by the offset method as described in the latest issue of Test Methods and Definitions A 370.

7.2 *Stress-Rupture Test:*

TABLE 5 Stress Rupture Requirements

Grade	Class	Test Temperature, °F [°C]	Stress, min		Time to Rupture, min, h[A]	Elongation, min, %
			ksi	MPa		
660	A, B, and C	1200 [650]	56	385	100	5
651	A and B	1200 [650]	40	275	100	5
662	A and B	1200 [650]	55	380	100	5
665	A	1200 [650]	75	515	100	3
	B	1200 [650]	70	485	100	5

[A] The combination bar specimen shown in Fig. 1 shall be tested continuously at the temperature and at the minimum stress specified or at a greater stress and shall rupture in a time not less than that specified.

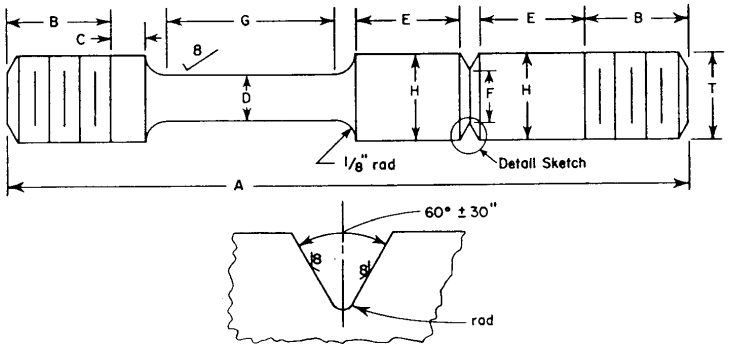

FIG. 1 Combination Smooth-Notch Stress-Rupture Test Specimen
(See Table 5)

TABLE 6 Test Specimen Dimensions

NOTE 1—Surfaces marked [B], finish to 8 μin. [0.2 μm] rms or better.
NOTE 2—The difference between dimensions *F* and *D* shall not exceed 0.0005 in. [0.01 mm] for specimens 1 or 2. The difference shall not exceed 0.001 in. [0.02 mm] for specimens 3, 4, 5, or 6.
NOTE 3—Taper the gage length *G* to the center so that the diameter *D* at the ends of the gage length exceeds the diameter at the center of the gage length by not less than 0.0005 in. [0.01 mm] nor more than 0.0015 in. [0.04 mm].
NOTE 4—All sections shall be concentric about the specimen axis within 0.001 in. [0.02 mm].
NOTE 5—Thread size *T* shall be equal to or greater than diameter *H*.
NOTE 6—Dimensions *A* and *B* are not specified.
NOTE 7—Length of shoulder *C*—⅛ + 1/32 −0 in. [3.2 + 0.8 mm].
NOTE 8—Length of shoulder *E*—⅜ + 1/32 −0 in. [10.0 + 0.8 mm].

Specimen Type	Mid-length Gage Dia *D* and Notch-Root Dia *F*	Gage Length, *G*	Shoulder Diameter, *H*	Notch-Root Radius
	Inches			
1	0.125	0.5	0.177	0.005
2	0.160	0.65	0.226	0.005
3	0.178	0.75	0.250	0.005
4	0.252	1.0	0.375	0.007
5	0.357	1.5	0.500	0.010
6	0.505	2.0	0.750	0.015
Tolerance	±0.001	±0.05	±0.003	±0.0005
	Millimetres			
7	3.17	12.0	4.5	0.13
8	4.06	17.0	5.5	0.13
9	4.52	20.0	6.5	0.13
10	6.40	25.0	9.5	0.18
11	9.07	40.0	12.0	0.25
12	12.8	50.0	19.0	0.38
Tolerance	±0.025	±1.3	±0.1	±0.01

7.2.1 *Requirements*—The material shall conform to the stress-rupture requirements prescribed in Table 5 for design temperatures above 800°F [427°C]. Material not stress-rupture tested shall be permanently stamped NR.

7.2.2 The number of specimens shall be the same as the required number of tension test specimens.

7.2.3 The test location and orientation shall be the same as that required for the tension test specimens.

7.2.4 *Test Method:*

7.2.4.1 The rupture test shall be performed in accordance with Practice E 139.

7.2.4.2 A combination smooth and notched test specimen, machined to the dimensions prescribed in Fig. 1 and Table 6, shall be tested in accordance with the stress-rupture requirements prescribed in Table 5. The test shall be continued to rupture. The rupture shall occur in the smooth section of the bar.

7.2.4.3 As an alternative procedure and, when specifically approved by the purchaser, separate smooth and notched test specimens, machined from adjacent sections of the same piece, with gage sections conforming to the respective dimensions of Table 6, may be tested under the above conditions. The notched specimen need not be tested to rupture but shall not rupture in less time than the companion smooth specimen.

7.2.4.4 When the minimum specified time to rupture in Table 5 has been achieved, incremental loading may be used to accelerate the time to rupture. At intervals of 8 to 16 h, preferably 8 to 10 h, the stress shall be increased in increments of 5000 psi [34.5 MPa]. Rupture location, and elongation requirements shall be as prescribed in Table 5, 7.2.4.2, and 7.2.4.3.

7.3 *Hardness Test:*

7.3.1 *Requirements*—The material shall conform to the room temperature hardness requirements prescribed in Table 7.

7.3.2 *Number of Tests:*

7.3.2.1 *Bars 2 in. [50 mm] and Over*—One test on each mill-treated length.

7.3.2.2 *Bars under 2 in. [50 mm]*—One test per bar on at least 10 % of the bars.

7.3.3 *Test Locations*—The hardness test shall be made at the center of the cross section for bars up to 1 in. [25 mm] in diameter, and at the midradius on bars 1 in. [25 mm] and larger in diameter.

7.3.4 *Test Method*—The test shall be performed in accordance with Test Methods and Definitions A 370.

8. Dimensions and Permissible Variations

8.1 Standard permissible variations in sizes of bars shall be as set forth in Table 8 for hot-rolled bars and in Table 9 for cold-finished bars.

8.2 Headed bolts shall be semi-finished, hexagonal in shape, and in accordance with the dimensions of ANSI B18.2.1. Nuts shall be hexagonal in shape, and in accordance with the dimensions of ANSI B18.2.2. Unless otherwise

TABLE 7 Mechanical Property Requirements

Grade	Class	Tensile Strength, min		Yield Strength (0.2 % Offset), min		Elongation in 4 × Diam[A], min, %	Reduction of Area, min, %	Brinell Hardness Number	Approximate Rockwell Hardness, B and C	
		ksi	MPa	ksi	MPa				min	max
660	A, B, and C	130	895	85	585	15	18	248–341	99 HRB[D]	37 HRC
651	A	100	690	70[B]	485	18	35	217–277	95 HRB	29 HRC
				60[C]	415					
	B	95	655	60[B]	415	18	35	212–269	93 HRB	28 HRC[E]
				50[C]	345					
662	A	130	895	85	585	15	18	255–321	100 HRB[D]	35 HRC[E]
665	B	125	860	80	550	15	18	248–321	99 HRB	35 HRC
	A	170	1170	120	830	12	15	311–388	32 HRC	41 HRC
	B	155	1070	120	830	12	15	311–388	32 HRC	41 HRC

[A] See Fig. 6 of Test Methods and Definitions A 370.
[B] Material sizes 3 in. [76 mm] and under in diameter.
[C] Material sizes over 3 in. [76 mm] in diameter.
[D] Conversion numbers taken from Test Methods and Definitions A 370, Table 3D.
[E] Conversion numbers taken from Specification A 193/A 193M, Table 2 (austenitic steels); others by interpolation.

TABLE 8 Permissible Variations in Size of Hot-Rolled Bars

Specified Size	Permissible Variations from Specified Size		Out of Round
	Over	Under	
	Inches		
5/16 and under	0.005	0.005	0.008
Over 5/16 to 7/16, incl	0.006	0.006	0.009
Over 7/16 to 5/8, incl	0.007	0.007	0.010
Over 5/8 to 7/8, incl	0.008	0.008	0.012
Over 7/8 to 1, incl	0.009	0.009	0.013
Over 1 to 1 1/8, incl	0.010	0.010	0.015
Over 1 1/8 to 1 1/4, incl	0.011	0.011	0.016
Over 1 1/4 to 1 3/8, incl	0.012	0.012	0.018
Over 1 3/8 to 1 1/2, incl	0.014	0.014	0.021
Over 1 1/2 to 2, incl	1/64	1/64	0.023
Over 2 to 2 1/2, incl	1/32	0	0.023
Over 2 1/2 to 3 1/2,incl	3/64	0	0.035
Over 3 1/2 to 4 1/4, incl	1/16	0	0.046
Over 4 1/2 to 5 1/2, incl	5/64	0	0.058
Over 5 1/2 to 6 1/2, incl	1/8	0	0.070
Over 6 1/2 to 7 1/2, incl	5/32	0	0.085
	Millimetres		
8.0 and under	0.13	0.13	0.20
Over 8.0 to 11.0, incl	0.15	0.15	0.23
Over 11.0 to 16.0, incl	0.18	0.18	0.25
Over 16.0 to 22.0, incl	0.20	0.20	0.30
Over 22.0 to 25.0, incl	0.23	0.23	0.33
Over 25.0 to 29.0 incl	0.25	0.25	0.38
Over 29.0 to 32.0, incl	0.28	0.28	0.41
Over 32.0 to 35.0, incl	0.30	0.30	0.46
Over 35.0 to 38.0, incl	0.35	0.35	0.53
Over 38.0 to 51.0, incl	0.40	0.40	0.58
Over 51.0 to 63.0, incl	0.80	0	0.58
Over 63.0 to 89.0, incl	1.2	0	0.89
Over 89.0 to 114, incl	1.6	0	1.2
Over 114 to 140, incl	2.0	0	1.5
Over 140 to 165, incl	3.2	0	1.8
Over 165 to 191, incl	4.0	0	2.2

TABLE 9 Permissible Variations in Size of Cold-Finished Bars

Specified Size, in. [mm]	Permissible Variations from Specified Size, in. [mm][A]	
	Over	Under
Over 1/2 to 1 [13 to 25], excl	0.002 [0.05]	0.002 [0.05]
1 to 1 1/2 [25 to 38], excl	0.0025 [0.06]	0.0025 [0.06]
1 1/2 to 4 [38 to 100], incl[B]	0.003 [0.08]	0.003 [0.08]

[A] When it is necessary to heat treat or heat treat and pickle after cold finishing, because of special hardness or mechanical property requirements, the permissible variations are generally double those shown in the table.

[B] For size tolerances of sizes over 4 in. [100 mm], the manufacturer should be consulted.

specified, the ANSI Standard heavy bolt and nut series shall be used. If socket head fasteners are required, the dimensions shall be in accordance with ANSI B18.3, as specified by the purchaser.

8.3 All bolts, stud bolts, and accompanying nuts, unless otherwise specified by the purchaser, shall be threaded in accordance with ANSI B1.1, Class 2A to 2B fit, or British Whitworth threads when specified.

8.4 Bolts, screws, studs, and stud bolts shall be pointed. Points shall be flat and chamfered or rounded at option of the manufacturer. Length of point on studs and stud bolts shall be one to two complete threads as measured from the extreme end parallel to the axis. Length of studs and stud bolts shall be the threaded length and shall be measured from first thread to first thread.

9. Workmanship, Finish and Appearance

9.1 Finished parts shall have a workmanlike finish, maximum 63 µin. [1.6 µm] AA on the threads, body underhead fillet, and bearing area.

10. Workmanship and Quality Level Requirements

10.1 The material shall be uniform in quality and free of defects that would be detrimental to the intended service. Such defects may be determined by conventional test methods, as specified on the purchase order.

11. Inspection

11.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with the specification. Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All tests and inspections shall be made at the place of manufacture, unless otherwise agreed to.

12. Rejection and Rehearing

12.1 *Rejection*—Unless otherwise specified, any rejection based on tests made in accordance with this specification shall be reported to the manufacturer within 60 days from the receipt of the material by the purchaser. Material that shows injurious defects subsequent to its acceptance at the manufacturer's work will be rejected and the manufacturer shall be notified.

12.2 *Rehearing*—Specimens tested in accordance with this specification that represent rejected material shall be preserved for 2 months from the date of the test report. In case of dissatisfaction with the results of the test, the manufacturer may make claim for a rehearing within that time.

13. Certification

13.1 The producer's certification that the material was manufactured and tested in accordance with this specification together with a report of the test results shall be furnished at the time of shipment. The specification designation included on test reports shall include year of issue and revision letter, if any.

14. Product Marking

14.1 *Bars*—Each lift, bundle, or box shall be properly tagged with durable tags (metal, plastic, or equivalent), showing the heat number, type, condition, specification designation (A 453/A 453M), and size. The specification number marked on the material need not include specification year of issue and revision letter.

14.2 *Bolts, Nuts, Screws, Studs, and Steel Bolts*—Grade and manufacturer's identification symbols shall be applied to one end of studs 3/8 in. [10 mm] in diameter and larger and to the heads of bolts 1/4 in. [6 mm] in diameter and larger. (If the available area is inadequate, the grade symbol may be

marked on one end and the manufacturer's identification symbol marked on the other end.) In addition to the identification symbols (grade and class) shown in Table 2, the type designation 2 shall also appear on all roll-threaded bolting material so processed. Absence of the type designation number indicates Type 1 processed material or machine-cut threads.

14.3 For purposes of identification marking, the manufacturer is considered the organization that certifies the fastener was manufactured, sampled, tested, and inspected in accordance with the specification and the results have been determined to meet the requirements of this specification.

14.4 *Bar Coding*—In addition to the requirements in 14.1, 14.2, and 14.3, bar coding is acceptable as a supplementary identification method. Bar coding should be consistent with AIAG Standard B-5 02.00. If used on small items, the bar code may be applied to the box or a substantially applied tag.

15. Keywords

15.1 marking; revision letter; year date

SUPPLEMENTARY REQUIREMENT

The following supplementary requirement shall apply only when specified by the purchaser in the inquiry, contract, and order.

S1. Marking

S1.1 Grade and manufacturer's identification symbols shall be applied to one end of studs and to the heads of bolts of all sizes. (If the available area is inadequate, the grade symbol may be marked on one end and the manufacturer's identification symbol marked on the other end.) For bolts and studs smaller than ¼ in. [6 mm] in diameter and for ¼-in. [6 mm] studs requiring more than a total of three symbols, the marking shall be a matter of agreement between the purchaser and the manufacturer.